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Virtual Worlds: Theoretical Perspectives and Research Methods

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Theoretical perspectives

Second Life unites heterogeneous phenomena of the recent history of computing: virtual reality, massively multiplayer online games (MMOGs), open source, Web 2.0. It is a publicly Internet-accessible 3D environment created in 2002 by Californian company Linden Lab and launched three years later, which presents itself as a persistent, open, unlimited, highly customizable space. The interface and the iconography are strongly influenced by video games, but it cannot be considered a video game proper because of the lack of goals to achieve, points to gain, or levels to complete. It is certainly part of the class of environments that Castronova (2005) calls ‘synthetic worlds’, better known as ‘virtual worlds’. Malaby (2006) notes that the former term, although less common than the latter, is preferable because:

First, this highlights how these worlds are the product of human action—that is, they are built. Second, the term virtual, although having the advantage (through its associated uses, i.e., virtual reality) of quickly conveying an image of what these worlds entail in the popular imagination, nonetheless founders on the very distinction that animates it: the real and the virtual.

To its founder Philip Rosedale, Second Life represents the answer to the question ‘How do we use computers to create a digital simulation of the world?’ (Carless, 2006). The cofounder Cory Ondrejka defines virtual worlds as ‘engines of creation’ (Ondrejka, 2005). Therefore, at the base of the Second Life virtual world are both a mimetic function and a demiurgic function.

Rosedale said that he wanted to recreate the ‘metaverse’ imagined by Neal Stephenson (Snow Crash, 1992). In the same year when Stephenson’s novel was published, David Gelernter described the ‘mirror world’ (Mirror worlds, 1992). Previously, William Gibson had coined the term ‘cyberspace’ (Neuromancer, 1984). Jones (2013) notes that Gibson’s cyberspace had been anticipated by Vernor Vinge’s ‘Other Plane’ (True names, 1981). Thus, virtual worlds were often present in science fiction. However, formal definitions given by scholars have been rare. Bell (2008) suggests:

A synchronous, persistent network of people, represented as avatars, facilitated by networked computers.

In other words, virtual worlds combine these elements: 1. synchrony: collaborative activities need synchronous communication, 2. persistence: a virtual world does not cease to function when users log off, 3. networked people: users interact with one another and/or with the environment, 4. avatar representation: any action

taken by the user is actually presented as an action taken by the avatar, that is to say her digital representation, 5. networked computers: the required technical infrastructure.

The growth of Second Life was sudden. Its total area of about 1700 km² is larger than that of Hong Kong, and its topology consists of thousands of interconnected regions, about 10% of which are grouped into continents while the others are scattered islands. All in all, therefore, Second Life is based on the ‘archipelago metaphor’, which Prasolova-Førland and Divitini (2003) describe as:

a virtual world consisting of sea and islands and groups of islands [intended] to re-create the way in which communities and groups naturally are created and developed. Islands represent groups and individuals, their constellations into archipelagos are communities, and the links, bridges and roads serve as connections between them.

Compared to a single large hypothetical continent, the subdivision into islands promotes the formation of themed communities and the owners of land tend to assign a different function to each island. Since there are no restrictions in the selection of scenarios and activities to be included in each region, the number of environments and communities that can coexist in the synthetic world is virtually infinite. Their formation process is spontaneous and essentially anarchist. Second Life is thus a complex ecosystem, a digital organism in continuous fluctuation.

Not surprisingly, users of Second Life consider the digital space as a place of residence for all intents and purposes. Ondrejka (2005) writes:

Digital worlds’ residents already describe themselves as living in them and millions of people spend much, even most, of their waking lives in them. To them, digital worlds are real places by any useful definition and can only be understood within that framework. Dismissing the representation of digital worlds as unimportant or irrelevant misses out on basic aspects of what makes us human.

By ‘first life’ we mean the concrete dimension, non-digital, of an individual, also known as ‘real life’. By ‘second life’ we mean the actions of an avatar in a synthetic world. The presence of a person interacting in a virtual world is distributed between the latter and the real world. The very term ‘second life’ would not make sense in the absence of a prior life. Its activity is the realization of the ‘electronic presence’ described by Sobchack (1994):

electronic presence has neither a point of view nor a visual situation, such as we experience, respectively, with the photograph and the cinema. Rather, electronic presence disperses its being across a network.

Furthermore, according to Dibbell (1998), the real dimension always has some virtual aspects:

Socio-political reality is not that different, finally, from the virtual kind, and [...] a human being never inhabits a physical landscape, without also inhabiting its ghostly abstract counterpart—the geography of language, law, and fantasy we overlay, collectively, on everything we look at.

In this regard, Castronova (2005) uses the metaphor of a porous membrane to describe the permeability between synthetic world and tangible reality:

Indeed it cannot be sealed completely; people are crossing it all the time in both directions, carrying their behavioral assumptions and attitudes with them. As a result, the valuation of things in cyberspace becomes enmeshed in the valuation of things outside cyberspace.

Both in the virtual world and in reality, the person interacts with others using symbolic systems. In both cases, these systems are arbitrary, conventional, relative. The meaning is not intrinsic to the material—atomic or digital—but it is always a socio-cultural construct. Nor is the identity intrinsic to the material, but is distributed in a variety of texts, practices and processes, such as digital messaging or the actions of the avatar in Second Life.

Another key principle is that of ‘agency’, which Murray (1998) describes as:

the satisfying power to take meaningful action and see the results of our decisions and choices. [...] we do not usually expect to experience agency within a narrative environment. Even in the rare circumstances when we are invited to participate in a traditional narrative form, our participation is circumscribed in a way that generally limits our sense of agency.

Thus, by agency we mean the exercise of the capacity for action of a subject within a non-narrative context. By virtue of this exercise, the subject can enjoy the results of their work in a responsive space, for example, the real life or a synthetic world.

In a synthetic world, agency is also manifested through the ability to create objects and structures. This aspect is of fundamental importance in the case of Second Life, which was designed to allow users to create all the content within the virtual space (Rosedale and Ondrejka, 2003; Ondrejka, 2005; Rymaszewski et al., 2007), even in collaboration. For Kohler et al. (2011a,b), virtual worlds are co-creation tools. Inside Second Life, any new artifact can be the result of a co-creation process. Rosedale says (Rymaszewski et al., 2007, foreword):

And those million users—you—have created quite a world. You add millions of objects to Second Life—in the form of cars, clothes, castles, and every other kind of thing you can imagine—every day. You spend close to \$5 million there every month; and that’s money you spend not on the things Linden Lab creates, but on the things that other users have created and added to the world. To me, that’s the beauty of Second Life: all we’ve created is a platform, an almost empty world; where we got lucky is in the fact that you came along and breathed life into it. If Second Life is a world at all, it’s because you’ve created it.

Therefore, Second Life users are not mere consumers, but ‘fans’, as in particularly active consumers, who participate in the construction of the texts they consume. For Fiske (1989), the ‘fandom’ is an intensified form of popular culture, and the fan is an ‘excessive reader’. This component of excess refers to the tendency of fans to take a deeper approach, compared to the ordinary reader, to the cultural

artifacts of their interests, and, in the classification of Reeves et al. (1996), is the aspect that distinguishes the ‘avid fans’ from the ‘casual viewers’ and the ‘devoted viewers’. Every type of public user attempts, in some way, to use their creativity to consume and derive meaning from the texts, but fans are distinguished by the use of their creativity in the production of texts. Consequently, the user can also become an extension and co-creation of the artifacts themselves.

In real life, fans have a set of production and distribution mechanisms independent of the official media industries, which Fiske (1992) defines ‘shadow cultural economy’ and which gives fans:

opportunities to make meanings of their social identities and social experiences that are self-interested and functional. [This] ‘empowered social behaviour’ [can] enhance the fan’s power over, and participation in, the original industrial text.

However, in Second Life, the cultural economy is not relegated to the shadows, but is a constitutive part of the synthetic world itself. Therefore, Fiske observes,

This melding of the team or performer and the fan into a productive community minimizes differences between artist and audience and turns the text into an event, not an art object.

Fans’ productive activity can be divided into three categories (Fiske, 1992): ‘semiotic productivity’, ‘enunciative productivity’ and ‘textual productivity’. The first is a predominately subjective stage, in which the fan creates a social meaning from the cultural resource conveyed by the text and applies it in their lives—such as a Madonna fan who sees the singer as a model of femininity, or as a model of sexual freedom. The enunciatory production occurs when the meaning produced in the semiotic step is shared with the outside world, either through verbal language or through behavior. Finally, with textual production the fan creates new content-based texts that are of interest to the community of fans. While the semiotic productivity and enunciative productivity are also present in the general public, the textual productivity is only present in the fandom community, because it is rare that the average viewer decides to create new content. Second Life encourages all three types of production, particularly emphasizing the third however. The latter is more complex than the other two because it requires considerable technical resources and time, and in some cases even economic resources. Indeed, fans do not produce new texts for financial gain, but, quite the contrary, often find themselves paying (Fiske, 1992). Fiske notes that, in real life,

Economics, too, limits the equipment to which may therefore often lack the technical smoothness of professionally-produced ones. There is also a difference in circulation; because fan texts are not produced for profit, they do not need to be mass-marketed, so unlike official culture, fan culture makes no attempt to circulate its texts outside its own community.

Actually, the cost incurred by the fans is not necessarily monetary. For example, apart from the cost of hardware and Internet connection, in most cases the economic investment in Second Life is modest, but the transformation of the raw

material—‘primitives’—into artifacts requires a considerable investment in the temporal, technical and creative sense. Furthermore, often in the synthetic world there is no noticeable difference in substance between the creations of the fans and the creations of the administrators. Not only is the means of distribution the same in both cases—that is, the synthetic world—but occasionally the artifacts produced by the fans may even have superior functionality or technical quality to that of the artifacts produced by the software house. Even the ‘viewer’ used to access the synthetic world has been improved over the years due to constant modifications introduced by fans to the source code released under open source license. Linden Lab wanted, therefore, to benefit from the production of the fans even outside the synthetic world. Fans are considered a ‘decentralized creative team’. Ondrejka (2005) explains that:

This decentralized creative team is closer to the community’s needs and wants than any developer could ever be, allowing creation and innovation to be efficiently applied. For the same reasons that Open Source users are often the best positioned to improve the products, Second Life residents are constantly improving their world, and they are not just doing it by making artifacts. [...] Importantly, this creation need not be the actual building of artifacts, but expands to building social networks, running groups, project management, event planning, and the myriad real-world activities that residents decide are needed in the digital world. The powerful realization is that these skills are real and transfer back into the real world.

For Jenkins (1992a), ‘media fans are consumers who also produce, readers who also write, spectators who also participate.’ Fans have made a major contribution to the success of Second Life, creating an ‘alternative social community’ geographically distributed and based on common interests:

What fandom offers is a community not defined in traditional terms of race, religion, gender, religion, politics, or profession, but rather a community of consumers defined through their common relationship with shared texts. Fans view this community in conscious opposition to the ‘mundane’ world inhabited by non-fans, attempting to construct social structures more accepting of individual difference, more accommodating of particular interests, and more democratic and communal in their operation.

Jenkins (1992b) also notes that:

Fandom [...] becomes a participatory culture which transforms the experience of media consumption into the production of new texts, indeed of a new culture and a new community.

Howard Becker has adopted the term ‘Art World’ to describe ‘an established network of cooperative links’ between institutions of artistic production, distribution, consumption, interpretation and evaluation: ‘Art Worlds produce works and also give them aesthetic values’.

The residents simultaneously play the role of producers and consumers of a meta-text that encourages socialization and social interaction. User-fans of Second Life are, at the same time, architects and residents, business owners and visitors. Specifically, this production is divided into three levels: social, cultural and economic.

By ‘social production’ we mean the network of interactions that develops between the service provider or the administrators—Linden Lab—and the users themselves, who in turn become content providers for all intents and purposes. This relationship, both vertical and hierarchical, is defined economically and legally through the signing of a contract. The administrators monitor the virtual world, keeping intervention to a minimum. They are ‘benevolent dictators’, who may at any time expel from digital paradise those who violate the etiquette, the rules shared by the members of the community. Some of these rules are imposed from on high, while others are the result of a negotiation between users and administrators.

A second relationship, of a horizontal type, is created between users of Second Life, who interact with each other both at the intratextual level—i.e. within the synthetic world—as well as at the extra-textual level—e-mails, forums, wikis, websites, blogs, podcasts, get-togethers, and so on. The audience in Second Life is layered: the activities, the roles, and the influence of the subjects vary greatly, and can perform multiple functions, from exploration to construction, from buying and selling to education. What is more, the administrators, while performing the role of supervisors, are also inhabitants and therefore users, as they live in the digital world vicariously through their avatars.

Cultural production is both internal and external. The first case concerns the artifacts produced within Second Life. We call this ‘cultural production’ because every artifact is iconographically and ideologically connoted. The external cultural production refers to everything that is produced in respect to, or based on, Second Life: news sites, blogs, essays, music videos, machinima.

The economic production takes place mainly within Second Life and concerns the flourishing trade in items and services. In 2003, Second Life was the first virtual world to allow users to maintain the intellectual property of the artifacts they created, and it was also the first to give users access to a ‘Marketplace’¹, which is a web platform for the buying and selling of virtual goods and which greatly simplified the search of artifacts for sale. In fact, in the absence of the Marketplace, the user would be forced to search for objects of interest by wandering through the maze of the metaverse. To indicate the economy of the virtual world, Robert Bloomfield coined the term ‘metanomics’ (metaverse-economics). The figures indicated by Linden Lab show a robust economy after ten years of activity, transactions in Linden dollars² reached a total value of \$3.2 billion, and the average daily number of transactions was recorded at 1.2 million.

If we consider the number of creators in a synthetic world, we have three scenarios before us: 1. there exists a single content creator, that is, the software company that created the synthetic world, 2. there exists a limited group of content creators, whose artifacts can be used by other users, 3. all users can create and therefore the

¹<https://marketplace.secondlife.com>

²The Linden dollar is the currency of Second Life, convertible into US dollars. In October 2013, the exchange rate was USD 1 = L\$ 230.

total number of creators is potentially unlimited. Although at the time of birth of the synthetic world it seemed to delineate a picture similar to that of the second scenario, after about two years it was evident that the creative activity was a process that concerned the entire population of residents. Indeed, one of the aspects that made the synthetic world interesting was the possibility for a user to modify and expand the contents previously made by other users, or reassemble them to obtain new combinations. Therefore, the exchange and sale of artifacts have established themselves as important activities, becoming the engine of a genuine virtual economy. In this context, Linden Lab has shown itself to be quite insightful in recognizing the intellectual property of every creator's artifacts. This choice is still against the tide within MMOGs and, more generally, within the entire gaming industry.

Bruns (2006, 2007) defines 'produsage' as the process of co-creation with which users improve, extend and assemble the content produced by others:

In collaborative communities the creation of shared content takes place in a networked, participatory environment which breaks down the boundaries between producers and consumers and instead enables all participants to be users as well as producers of information and knowledge—frequently in a hybrid role of produser where usage is necessarily also productive. Produsers engage not in a traditional form of content production, but are instead involved in produsage—the collaborative and continuous building and extending of existing content in pursuit of further improvement. Participants in such activities are not producers in a conventional, industrial sense, as that term implies a distinction between producers and consumers which no longer exists; the artefacts of their work are not products existing as discrete, complete packages; and their activities are not a form of production because they proceed based on a set of preconditions and principles that are markedly at odds with the conventional industrial model.

Ondrejka (2005) compares the 'primitives' of Second Life to the atoms that make up matter in the real world. The latter can be combined to obtain complex structures, and in a similar manner the primitives can be combined to obtain complex structures. Therefore in both cases we can talk about 'atomistic construction'. However, changing the structures obtained in the real world is usually not an easy task, and in some cases it is impossible. This problem does not exist in the synthetic world, where instead the artifact is not subject to decay, can be copied endlessly without cost and be changed countless times by an infinite number of users. The synthetic world is an excellent example of an environment in which produsage, as described by Bruns (2008), may take place:

Second Life [...] allows for the gradual formation of social structures through player engagement—a form of communal evaluation between peers—as well as the more explicit communal policing of content created within the game, ensuring for example that content created by players in the game does not negatively affect others' participation in the world. From such communal engagement, social structures are gradually beginning to form, and are leading to the development of fluid heterarchies

of participants residing at specific locales in the gamespace, and even to the development of local government organizations covering specific, limited spaces in the online world. In addition, of course, the world itself remains permanently unfinished as participants move through it, create content, and place it in various locations (from which it may be removed again by other residents or the Second Life system itself)—much like that of our ‘First Life’, the world of Second Life remains a process, not a product. Finally, though, ownership of the space is more conflicted: although the underlying technological framework of Second Life is of course owned and operated by its creator Linden Labs, the in-game world overall is seen very much as communal property of all residents, but individual property in real estate and objects also exists; it therefore combines aspects of gated community, open commons, and individualist society within the same space.

With regard to the intellectual property rights, Bruns (2006) observes:

Iterative engagement with content in a continuous process of evolutionary development require new approaches to the recognition and enforcement of intellectual property rights. A strict enforcement of such rights will tend to stifle the ability of later producers to build on the work of their predecessors, and many produsage environments utilise open source or creative commons-style licencing frameworks. At the same time, a complete release of content into the public domain, amounting to producers giving up their legal and moral rights to be recognised and acknowledged as the creators of intellectual property, would often turn out to be counterproductive, since one of the motivations for producers still remains the ability to be seen as a contributor to distributed produsage efforts. Produsage sites therefore must negotiate a middle path between IP regimes which enable as far as possible their participants’ engagement with one another’s content, and approaches which maintain individuals’ rights to be acknowledged as content contributors.

Although in Gartner’s ‘2013 hype cycle for human-computer interaction’ virtual worlds, and, more generally, virtual reality, are situated in the phase called ‘trough of disillusionment’ (Ghubril and Prentice, 2013) the figures released by Linden Lab show an economy in good health. Before entering the stage called ‘plateau of productivity’, it is foreseeable that the underlying technologies of virtual worlds will continue to evolve and be the subject of research. Wasko et al. (2011) propose the following research areas:

1. how the rules system imposed by virtual world creators influences both virtual world and real world interactions,
2. how perspectives around the design of information systems need to adapt and change to account for the flexibility and viarability in virtual world environments,
3. how users engage in sensemaking around these technologies,
4. how the person-avatar relationship is established and developed,
5. how engaging in a virtual world environment creates a more immersive user experience,

6. how virtual world experiences impact co-creation, innovation, purchasing, and other human-avatar behaviors.

The potential, promise and problems associated with virtual worlds still need to be explored.

Research methods

In the last few years several authors have identified a classification for how both profit and not-for-profit organizations use multi-user virtual environments (MUVEs), including areas such as marketing, virtual shopping, communication, PR, research, innovation, collaboration, education and learning, training, recruitment. In most cases, a new virtual space must be created in a virtual world, in order to suit the organization's specific needs. Such a virtual space is composed of a landscape, buildings, and objects with which avatars might interact. To encourage visits and engagement, the design of the virtual environment is critical. Only when avatars experience an environment that features immersive and appealing surroundings as well as interactive and engaging objects will they visit the place, spend time there, and return again.

The design process requires attention to ensure that the various design needs are inventoried, several alternatives explored, and that finally a virtual space is created addressing the initial needs. Such an approach would be valuable for both practitioners and researchers, who however tend to create virtual artifacts through an trial-and-error process. In a research setting, this approach has two major shortcomings. The first is that, if the system fails, few insights have been gained into the basic research question. For example, the failure may be more due to the limitations of the implementation than to the idea itself. The second major problem is that it can be difficult to generalize from a specific system to generic principles. A scientifically rigorous methodology would solve these problems and help achieve better results from a technical as well as aesthetic perspective. Recent literature has identified some conceptual frameworks that are useful for this purpose.

De Freitas and Oliver (2006) combine elements from learning theory and human-computer interaction to design a framework made up of these four components: learner, learning theory, representation of environment, and context. The main purpose of this framework is the evaluation of simulation-based learning activities, but it can also be used as a guide for the development of learning games and simulations.

Davis et al. (2009) take a social-technical stance and present a conceptual model for metaverse (i.e. virtual worlds) research consisting of five components: 1. metaverse, 2. avatars, 3. behaviors, 4. metaverse technology capabilities, 5. outcomes. The authors highlight the interaction of avatars and name a range of topics such as representation, presence, and immersion. However, the article does not directly discuss the design process of a virtual environment.

Drettakis et al. (2007) focus on the tools needed to create a virtual environment in the field of architecture and urban planning. One important criterion for

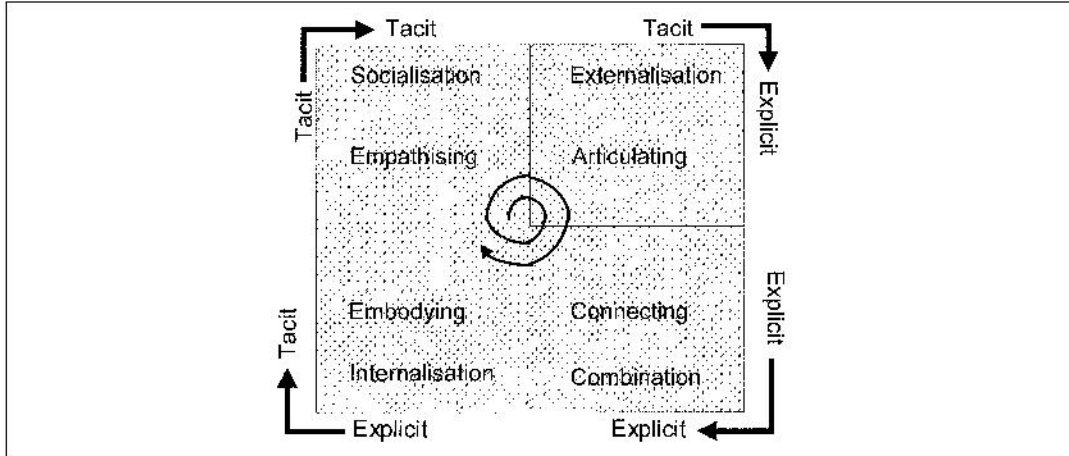


Figure 1: The SECI model (Nonaka et al., 2000)

improving such tools is the level of realism. The study provides useful insights in the design process of such a tool, as they explain how they specified requirements, developed, and improved a prototype based on testing and evaluation.

Parsons et al. (2008) explore the usefulness of virtual worlds, to create a learning environment. He explains that, before building the environment, the researcher should develop an analytical framework to guide the thinking about developing virtual learning environments. Looking at the design process of a virtual university, the authors recognized the potential of virtual environments and developed the analytical framework for that purpose. Although the actual design process of the virtual environment is not explicit, one can identify concrete steps such as needs analysis and development.

Minocha and Roberts (2008) apply Nonaka and Takeuchi’s SECI model to the design of activities involving a combination of 3D virtual worlds and 2D tools. Nonaka and Takeuchi (1995) note that while knowledge is shared between individuals within an organization, it moves from being ‘tacit’ knowledge to ‘explicit’ knowledge and vice versa. On the one hand, explicit knowledge is constituted by artifacts such as documents, videos, or podcasts, which have been created to communicate with other people and can be processed, stored and transmitted. On the other hand, tacit knowledge is what the person ‘knows’, and is derived from experience. Tacit knowledge is deeply rooted in actions, emotions, values and ideals. Nonaka and Takeuchi also note that as knowledge moves from tacit to explicit, it passes through ‘four modes of knowledge conversion’. Figure 1 shows the four modes of knowledge: 1. socialization (from tacit knowledge to tacit knowledge), 2. externalization (from tacit knowledge to explicit knowledge), 3. combination (from explicit knowledge to explicit knowledge), 4. internalization (from explicit knowledge to tacit knowledge). The movement forms a spiral, not a circle, because tacit and explicit knowledge expands in both quality and quantity through the conversion process (Nonaka et al., 2000). Following this model, Minocha and Roberts (2008) provide guidelines to design collaborative activities in a 3D virtual world and to determine the optimal combination for blended approaches that combine 2D environments such as blogs, wikis and forums with 3D learning environments.

With regard to business and innovation, Nambisan and Nambisan (2008) study

the design of virtual customer environments (VCEs) in the context of online product forums. They suggest that four experience dimensions must be considered in order to serve participants' needs in virtual environments: 1. pragmatic experience, 2. sociability experience, 3. usability experience, 4. hedonic experience. The first aspect relates to the customer's experience in realizing product-related informational goals in a virtual customer environment, while the underlying social and relational aspects of such interactions form the sociability component. The usability dimension is defined by the quality of the human-computer interactions. Finally, interactions in virtual environments can be mentally stimulating or entertaining, referring to the hedonic component. Based on these four components of experience, Nambisan and Nambisan suggest a set of implementation principles and strategies that companies can apply in online environments to get a predictable impact on the customer experience.

The four experience dimensions have also been studied by Kohler et al. (2011a,b), who consider virtual worlds as new co-creation systems. Co-creation is a process during which the company allows consumers to take an active role in order to create value (Prahalad and Ramaswamy, 2004). The Internet has provided companies with many opportunity to exploit consumers' innovative potential and knowledge, for example when creating and evaluating new product ideas and virtual prototypes. Virtual worlds are considered as sources of co-creation for two reasons. Firstly, incorporating the technological advances of virtual worlds into co-creation practice enriches existing web-based methods by allowing for real-time, media-rich collaboration between consumers and companies. Secondly, virtual worlds such as Second Life encourage people to experiment and create. Interestingly, the whole content of the Second Life virtual world is the result of a co-creation process, which was not sheer luck but was based on deliberate incentives for individual creation (Ondrejka, 2005).

Helms et al. (2010) describe how design science research can be used to design co-creation systems in virtual worlds, namely in Second Life. Design science research (DSR) is a structured and rigorous methodology, which uses design as a research method (Vaishnavi and Kuechler, 2004), and aims to generate scientific knowledge through a problem solving process (Hevner et al., 2004) that is used to develop an artifact. Such artifacts include, but are not limited to, algorithms (e.g. for information retrieval), human-computer interfaces, and system design methodologies (Vaishnavi and Kuechler, 2004). The design science paradigm has been evaluated multiple times in the literature over the past ten years in terms of its application to information systems (Hevner et al., 2004; Vaishnavi and Kuechler, 2004; Iivari, 2007; Peffers et al., 2007), but it originally stems from the design methodology used in engineering sciences (March and Smith, 1995). Today it can be more generally applied to engineering and information technology (March and Smith, 1995). Its goal is to create innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, management, and use of information systems can be accomplished (Hevner et al., 2004). Design science basically consists of two activities: 1. building, i.e. the process of constructing an artifact for a specific purpose, 2. evaluation, i.e. the process of determining how well the artifact performs (March and Smith, 1995). Hevner et al. (2004) point out that the main questions are: 'What utility does the new artifact provide?' and

‘What demonstrates that utility?’, and that:

Evidence must be presented to address these two questions. That is the essence of design science. Contribution arises from utility. If existing artifacts are adequate, then design-science research that creates a new artifact is unnecessary (it is irrelevant). If the new artifact does not map adequately to the real world (rigor), it cannot provide utility. If the artifact does not solve the problem (search, implementability), it has no utility. If utility is not demonstrated (evaluation), then there is no basis upon which to accept the claims that it provides any contribution (contribution). Furthermore, if the problem, the artifact, and its utility are not presented in a manner such that the implications for research and practice are clear, then publication in the IS literature is not appropriate (communication).

Therefore, Hevner et al. (2004) propose seven guidelines:

design-science research requires the creation of an innovative, purposeful artifact (Guideline 1) for a specified problem domain (Guideline 2). Because the artifact is purposeful, it must yield utility for the specified problem. Hence, thorough evaluation of the artifact is crucial (Guideline 3). Novelty is similarly crucial since the artifact must be innovative, solving a heretofore unsolved problem or solving a known problem in a more effective or efficient manner (Guideline 4). In this way, design-science research is differentiated from the practice of design. The artifact itself must be rigorously defined, formally represented, coherent and internally consistent (Guideline 5). The process by which it is created, and often the artifact itself, incorporates or enables a search process whereby a problem space is constructed and a mechanism posed or enacted to find an effective solution (Guideline 6). Finally, the results of the design-science research must be communicated effectively (Guideline 7) both to a technical audience (researchers who will extend them and practitioners who will implement them) and to a managerial audience (researchers who will study them in context and practitioners who will decide if they should be implemented within their organizations).

1. Design as an artifact: design-science research must produce a viable artifact, which according to March and Smith (1995) can be:
 - (a) a construct: concept,
 - (b) a model: problem and solution described as a set of propositions or statements expressing relationships among constructs,
 - (c) a method: set of steps (algorithm) used to perform a task,
 - (d) an instantiation: the realization of an artifact.
2. Problem relevance: the objective of design-science research is to develop technology-based solutions to important and relevant business problems.
3. Design evaluation: the utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods. Evaluation methods must be matched appropriately with the designed artifact, and can be:

- (a) Observational:
 - i. Case study: study the artifact in the business environment,
 - ii. Field study: monitor the use of the artifact in multiple projects;
 - (b) Analytical:
 - i. Static analysis: examine the structure of the artifact and its static qualities (e.g. complexity),
 - ii. Architecture analysis: study how the artifact fits into the technical architecture,
 - iii. Optimization: demonstrate inherent optimal properties of the artifact or provide optimality bounds on the behavior of the artifact,
 - iv. Dynamic analysis: study the dynamic qualities (e.g. performance) of the artifact in use;
 - (c) Experimental:
 - i. Controlled experiment: study the qualities (e.g. usability) of the artifact in a controlled environment,
 - ii. Simulation: execute the artifact with artificial data;
 - (d) Testing:
 - i. Black box/functional testing: execute the artifact interfaces to discover failures and identify defects,
 - ii. White box/structural testing: perform coverage testing of some metric (e.g. execution paths) in the artifact implementation;
 - (e) Descriptive:
 - i. Informed argument: use information from the knowledge base (e.g. relevant research) to build a convincing argument for the utility of the artifact,
 - ii. Scenarios: construct detailed scenarios around the artifact to demonstrate its utility;
 - (f) It is also possible to include an assessment of the artifact's style. The measurement of style depends on perception and taste. Sufficient degrees of freedom remain to express a variety of forms and functions in the artifact that are aesthetically pleasing to both the designer and the user.
 - 4. Research contributions: effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
 - 5. Research rigor: design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
 - 6. Design as a search process: the search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
 - 7. Communication of research: design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.
- At the same time, however, Hevner et al. (2004) advise:

against mandatory or rote use of the guidelines. Researchers, reviewers, and editors must use their creative skills and judgment to determine when, where, and how to apply each of the guidelines in a specific research project.

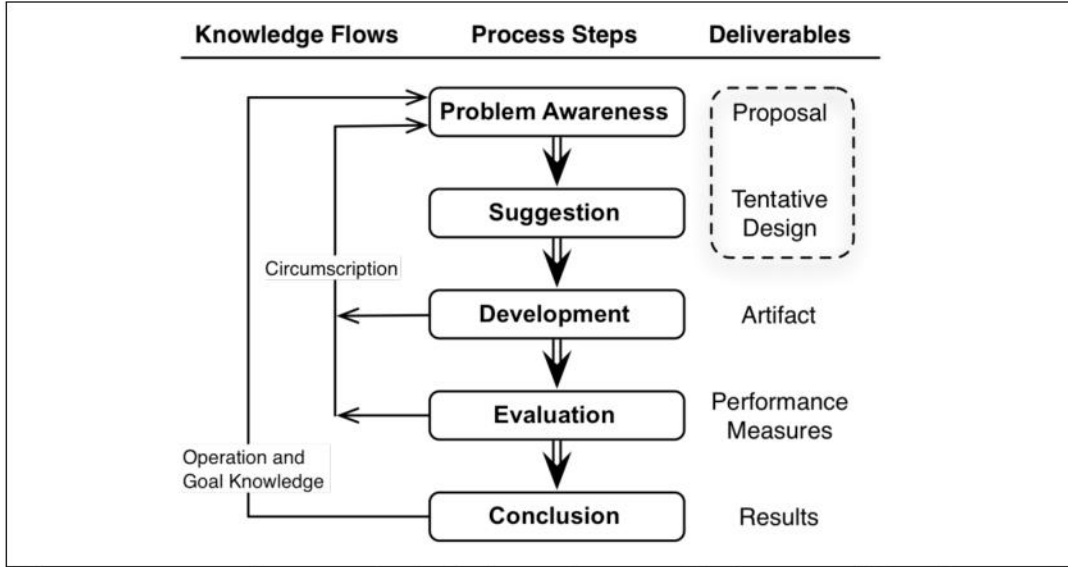


Figure 2: 5-step design cycle (Takeda et al., 1990; Vaishnavi and Kuechler, 2004; Helms et al., 2010)

Takeda et al. (1990) propose the 5-step design process model shown in figure 2, which is applied to design science research by Vaishnavi and Kuechler (2004):

1. problem awareness: finding an interesting problem in business, society or science,
2. suggestion: suggesting a possible design solution in the form of an artifact,
3. development: implementation of the artifact,
4. evaluation: the artifact is evaluated according to predefined criteria,
5. conclusion: the end of the research cycle.

Step 3 (development) and step 4 (evaluation) can be performed iteratively during the research effort, because the artifact is not expected to be flawless right away. The ‘circumscription’ arrow, which goes back to step 1 (awareness), indicates the iterative loop. Furthermore, while developing and evaluating the artifact, new questions may be raised that require a re-formulation of the problem resulting in further iterations from step 5 (conclusion) to step 1 (awareness).

Helms et al. (2010) associate the 5-step design cycle with Hevner et al.’s seven guidelines, as shown in figure 3.

Peppers et al. (2007) synthesized selected prior literature on the topic by proposing the design science research methodology process model shown in figure 4. This model, in comparison to the model shown in figure 2,

- breaks the ‘problem awareness’ step into two steps, ‘identify problem and motivate’ and ‘define objectives of a solution’,
- merges the ‘suggestion’ and ‘development’ phases into a single phase, ‘design and development’,
- breaks the ‘evaluation’ phase into two phases, ‘demonstration’ and ‘evaluation’,
- renames the ‘conclusion’ phase as ‘communication’.

A distinguishing feature of this model is the identification of the fact that the research can begin from several contexts: problem-centered initiation, objective-centered initiation, design and development initiation, client/context initiation.

Step	Guideline
1. Problem awareness	1. A new and innovative artifact needs to be developed. 2. The artifact needs to be a response to a clear and relevant business problem that is identified by the researchers.
2. Suggestion design	3. Proper evaluation measures and methods regarding the utility, quality and efficacy of a design artifact need to be defined. 4. The research outcome needs to have a clear research contribution and not only be limited to usefulness for practitioners.
3. Development	5. Proper research methods need to be applied in developing the artifact. 6. Several iterations are needed to tweak the artifact to the initial requirements.
4. Evaluation	3. The artifact needs to be evaluated using the evaluation measures and methods previously defined.
5. Conclusions	7. Results need to be communicated to practitioners and researchers.

Figure 3: Mapping of Hevner et al.’s guidelines to Takeda’s 5-step design cycle (Helms et al., 2010)

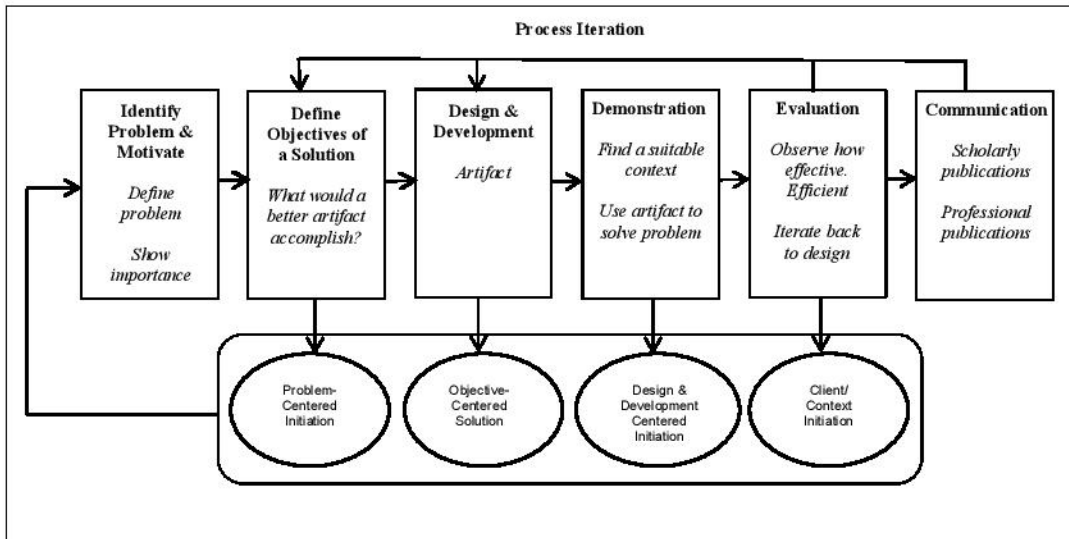


Figure 4: DSR methodology process model (Peppers et al., 2007)

Santos (2010) proposes the use of design-based research (DBR) as a viable methodology to do research in virtual worlds. Design-based research is an iterative methodology, related to design science research, which considers the social context as part of its unit of analysis, and is therefore suitable for an educational virtual environment. Not only does DBR test a certain design to find out how it is working, but it also lets new theory emerge during the process. The basic structure of the methodology is composed of three steps:

1. providing a description of the virtual world,
2. documenting and iterating through a cycle of implementation, findings and implications,
3. writing a final report integrating the findings of all the cycles.

Considering the iterative dynamic of this methodology, which evolves over time, it is crucial to document systematically the whole process because it is important to identify the changes as they occur. After the first cycle (step 2), the DBR methodology suggests repeating the process to revise the design and let the theory emerge. Thus, the set of implications that are reported as the result of the cycle is carefully studied to plan the next cycle of implementation/findings/implications. Before the new cycle, it is important to reflect upon the reasons for going into it. The total number of cycles depends on the nature of the research project itself.

In conclusion, we have seen how DSR focuses on the creation of artifacts, rather than on the mere observation of objects or phenomena. The concept of ‘learning through building—artifact construction’ (Vaishnavi and Kuechler, 2004) which is the defining feature of DSR is also particularly important to build objects and spaces within virtual worlds. DSR has been used by Helms et al. (2010) in Second Life and can be taken into consideration for future projects. In this way, in addition to creating an artifact, we will create new knowledge.

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